Ultrasound-guided plugged percutaneous biopsy of solid organs in patients with bleeding tendencies

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ABSTRACT

Objective: To establish and verify the utility of plugging biopsy tracts, using a combination of Gelfoam slurry and torpedo in the prevention of post-biopsy bleeding in patients at high risk of post-procedure haemorrhage following ultrasound-guided percutaneous biopsy of solid organs.

Design: Case series.

Setting: Radiology Department of a regional hospital in Hong Kong.

Patients: In our unit, all patients considered to be at high risk of post-biopsy haemorrhage of a solid organ underwent ultrasound-guided plugged percutaneous biopsy from year 2005 to 2012.

Interventions: All the included patients had undergone real-time ultrasound-guided biopsy of solid organs (liver in 10 and spleen in one patient). In all cases, a combination of a coaxial introducer needle and Temno needle were used. After adequate specimens were obtained, Gelfoam slurry (for distal embolisation) followed by Gelfoam torpedo (for proximal embolisation) were used to plug the biopsy tract.

Main outcome measures: Technical success, any post-biopsy haemorrhage treated by transfusion or other intervention, and plugging-related complications were reviewed for each patient.

Results: Technical success was achieved in all patients and none experienced post-biopsy haemorrhage treated by blood transfusion or any other intervention.

Conclusion: Plugging of the biopsy tract with Gelfoam slurry followed by Gelfoam torpedo is a direct and simple procedure that can safely and effectively prevent haemorrhage in patients at high risk of post-biopsy haemorrhage.

Hong Kong Med J 2014;20:107–12
DOI: 10.12809/hkmj133972

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This article was published on 22 Jul 2013 at www.hkmj.org.

New knowledge added by this study

- Plugging of the biopsy tract using a combination of Gelfoam slurry followed by Gelfoam torpedo is a new technique that has not been previously described.

Implications for clinical practice or policy

- Plugging of the biopsy tract using a combination of Gelfoam slurry and torpedo is safe and easy to undertake and should be used in patients at high risk of post-biopsy haemorrhage.

Introduction

Ultrasound-guided percutaneous biopsy is a well-established means for diagnosis of focal or diffuse disease in solid organs. It is generally safe and confers minimal risk of complications. However, it is contra-indicated in patients with bleeding tendencies, which means that histological diagnosis may be lacking and sometimes life-saving treatment cannot be commenced. Plugging of the biopsy tract is a promising technique to decrease the risk of post-biopsy haemorrhage, for which Gelfoam is the most commonly used agent. In this article, we share our experience in performing this procedure using Gelfoam slurry followed by Gelfoam torpedo in patients at high risk of post-procedure haemorrhage in our institution.

Methods

The Department of Radiology and Organ Imaging, United Christian Hospital, is the main radiology training centre of the Kowloon East Cluster, Hong Kong. Apart from diagnostic imaging, we provide both emergency and elective interventional radiology services. In the form of a retrospective study approved by our local ethics committee, since 2005, it has been our standard practice to plug the biopsy tract in all patients considered at risk of haemorrhage after having ultrasound-guided percutaneous biopsy

對高出血風險患者於超聲引導器官穿刺活檢後進行活檢道堵塞

曾慧勤、陸永恆、羅煦寧

目的：鑒於部份病人在進行超聲引導器官穿刺活檢後出現術後出血的風險較高，本研究旨在驗證合併使用明膠海綿膏和海綿條能否預防此類風險出現。

設計：病例系列。

安排：香港一所分區醫院的放射科。

患者：從2005到2012年期間，於上述醫院進行超聲引導器官穿刺活檢並被評估為有高出血風險的患者。

介入：所有患者均進行實時超聲引導穿刺活檢，包括肝臟10例和脾臟1例。所有病例均同時使用同軸導引針和Temno針。取得足夠樣本後，合併使用明膠海綿膏（作遠端栓塞）及明膠海綿條（作近端栓塞）將活檢道堵塞。

主要結果測量：每個病例的技術成功率、有否活檢後出血而需輸血或治療，以及與活檢道堵塞相關的併發症。

結果：所有病例均達至技術成功，並無病人於活檢後出血而須接受輸血或介入治療。

結論：合併使用明膠海綿膏和海綿條堵塞活檢道是一種直接和簡單的防止出血方法，對於活檢後有高出血風險的患者來說既安全又有效。

of a solid organ. Our departmental registry recorded all the cases receiving plugged percutaneous biopsy (PPB) of solid organs performed from 1 January 2005 to 30 September 2012. There was no reported refusal of the procedure by any patient. Demographic data, indication for the biopsy and for plugging of the biopsy tract, details of the biopsy technique, biopsy results, and any episodes of post-biopsy haemorrhage treated by transfusion or any other type of intervention were reviewed for each patient. Relevant details are listed in Table 1.

Technique

All PPBs were performed under strict aseptic conditions with instruments as shown in Figure 1. A biopsy path avoiding critical structures and major vessels was selected under ultrasound guidance. The length of the biopsy path starting from the organ capsule to the target region was measured (Fig 2a). A strip of Gelfoam of the same length and with a width of approximately 2 mm was cut from a sheet of Gelfoam. Before being cut, the sheet of Gelfoam was compressed manually to expel all air bubbles. A Gelfoam torpedo was formed by rolling the strip of Gelfoam into a rod-like structure (Fig 2b). The remaining Gelfoam sheet was then cut into tiny pledgets of around 2 mm x 2 mm in size. A syringe filled with Gelfoam pledgets and another syringe filled with saline were both connected to a 3-way stopcock. Macerating the suspension with two syringes and a 3-way stopcock allowed further decreases in size of the pledgets into a slurry (Fig 2c). After the Gelfoam torpedo and slurry were ready, the puncture site was injected with local anaesthetic (5-10 mL of 1-2% lignocaine) and a small skin incision was created. Patients were then instructed to hold their breath while a coaxial introducer needle (17G or 19G,

TABLE 1. Details of patient demographic data, indication for plugged biopsy, biopsy site and technique, and pathological results

Patient No.	Sex/ age (years)	Indication of biopsy	Biopsy site	Reason for plugged biopsy	Needle size (coaxial/ Temno needle in G)	No. of needle pass(es)	Complication	Pathology
1	F/66	Liver failure, suspected autoimmune hepatitis	Liver	INR=1.7, APTT=42.6 s	17/18	2	No	Autoimmune hepatitis
2	M/69	Liver mass	Liver	INR=1.4	19/20	3	No	Adenocarcinoma metastasis
3	M/58	Liver mass	Liver	Active oozing from biopsy tract	17/18	1	No	Hepatocellular carcinoma
4	F/72	Liver mass	Liver	Active oozing from biopsy tract	17/18	2	No	Stereo-hepatitis
5	F/54	Suspected autoimmune hepatitis	Liver	INR=1.3, APTT=37.2 s	19/20	3	No	Chronic hepatitis
6	F/40	Suspected cirrhosis	Liver	INR=1.4, Plt=90 x 10^9/L	17/18	3	No	Chronic hepatitis with cirrhosis
7	F/69	Suspected liver amyloidosis	Liver	Active oozing from biopsy tract	17/18	3	No	Cirrhosis
8	F/74	Splenic mass	Spleen	Hypervascular biopsy organ	19/20	1	No	Burkitt-like lymphoma
9	F/29	Suspected cirrhosis	Liver	INR=1.4, APTT=38 s, Plt=70 x 10^9/L	17/18	3	No	Lymphocytic infiltrates
10	M/47	PUO, PET-CT hypermetabolic liver	Liver	INR=1.5, APTT=50.6 s, Plt=62 x 10^9/L	17/18	4	No	Tuberculosis
11	F/58	Liver mass	Liver	Active oozing from biopsy tract	17/18	3	No	Hepatocellular carcinoma

Abbreviations: APTT = activated partial thromboplastin time; INR = international normalised ratio; PET-CT = positron emission tomography–computed tomography; Plt = platelet count; PUO = pyrexia of unknown origin

CareFusion; Waukegan [IL], US) was advanced to the target region. The stylet of the coaxial introducer needle was removed, with the outer sheath held firmly in place. A Temno biopsy needle (18G or 20G, CareFusion) was then inserted through the sheath under ultrasound guidance. Biopsy specimens were obtained in a standard manner. After removal of the Temno needle between passes, the stylet of the coaxial introducer needle was reinserted into the sheath to decrease the chance of haemorrhage. After adequate specimens were obtained by inspection, 1 to 2 mL of Gelfoam slurry was injected into the sheath of the coaxial introducer needle (Fig 3). The Gelfoam torpedo was then placed at the hub of the sheath of the coaxial introducer needle (Fig 4a) and pushed by the stylet until the echogenic tip of the stylet was advanced to the organ capsule (Fig 4b). The outer sheath was then withdrawn while keeping the stylet still (Fig 4c), so that the Gelfoam torpedo could be deployed along it and therefore sealing the biopsy tract. Finally, the entire coaxial introducer needle was removed.

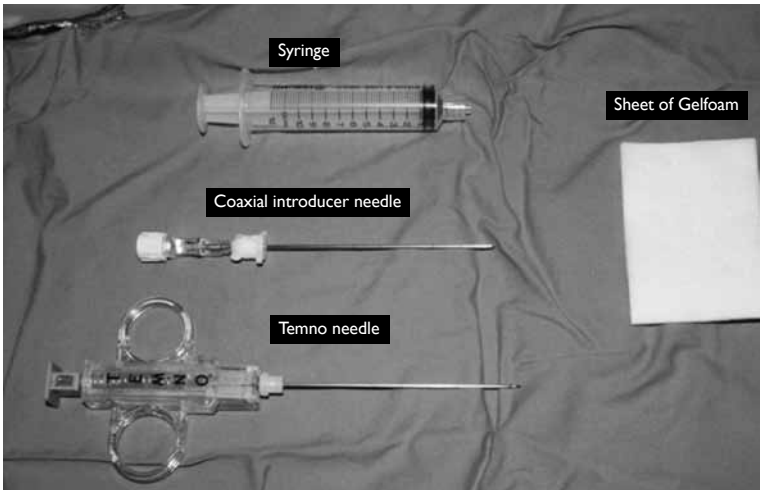

FIG 1. Instruments needed in plugged percutaneous biopsy

Results

During a 7-year period, we performed 11 cases of plugged percutaneous solid organ biopsy in 11 patients, all of whom were considered at high risk of post-biopsy bleeding due to the reasons listed in Table 1. The mean patient age was 58 (standard deviation [SD], 14) years. Three patients were male and eight were female. The target organ was the liver in 10 cases and the spleen in one. The indications for biopsy were to achieve a diagnosis of a focal mass in five cases, and characterisation of diffuse hepatic diseases in six (Table 1). The number of needle passes ranged from one to four, with a mean of 2.5 (SD, 0.9). In all cases, the combination of a coaxial introducer needle and Temno needle (both by CareFusion) were used. The combination of a 17G coaxial introducer needle and 18G Temno needle was used in eight biopsies, while the combination of a 19G coaxial introducer needle and 20G Temno needle was used thrice. All the biopsies were technically successful in obtaining adequate specimens for a histological diagnosis. None of the patients experienced post-biopsy haemorrhage treated by transfusion or any other form of intervention.

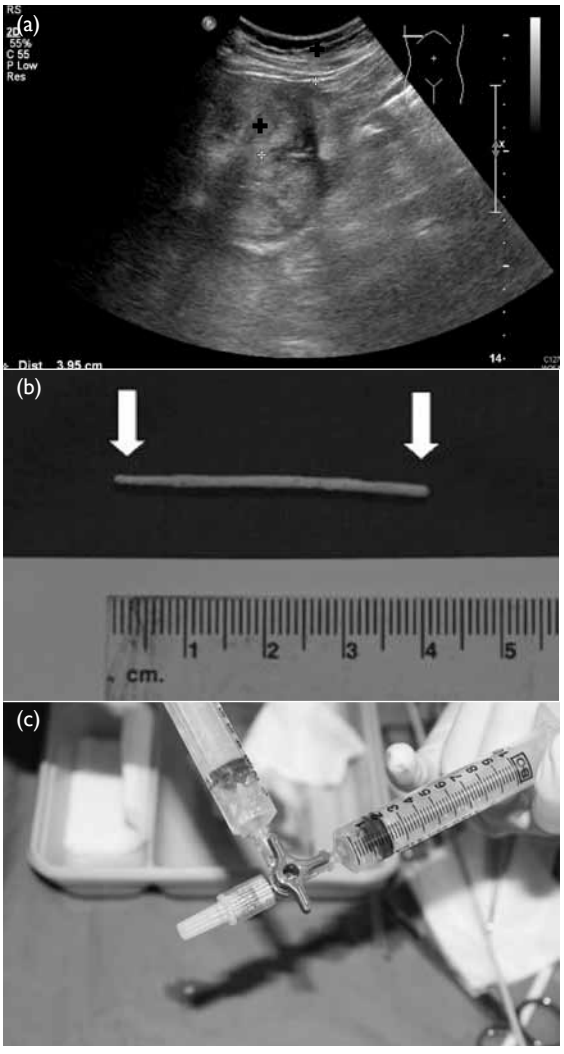

FIG 2. (a) The length of the biopsy path starting from the organ capsule to the target region is measured on ultrasonography. (b) A strip of Gelform of the same length with a width of 2 mm is cut from a sheet of Gelfoam. It is then rolled into a rod-like structure (torpedo). (c) Macerating the suspension of Gelfoam with two syringes and a 3-way stopcock allows further decrease in size of the pledgets

Discussion

Ultrasound-guided percutaneous solid organ biopsy is a well-established means of diagnosing focal or diffuse disease in solid organs. In general, it is safe and confers minimal risk of complications. Major and minor complication (mainly bleeding) rates of 0.8% and 2-3.8%, respectively, have been reported.[1,2] Many factors increase the risk of post-biopsy haemorrhage, which can be divided into lesional, technical, and patient-related. Lesional factors consist of

FIG 3. After adequate specimens are taken, 1-2 mL of Gelfoam slurry is injected to the sheath of coaxial introducer needle

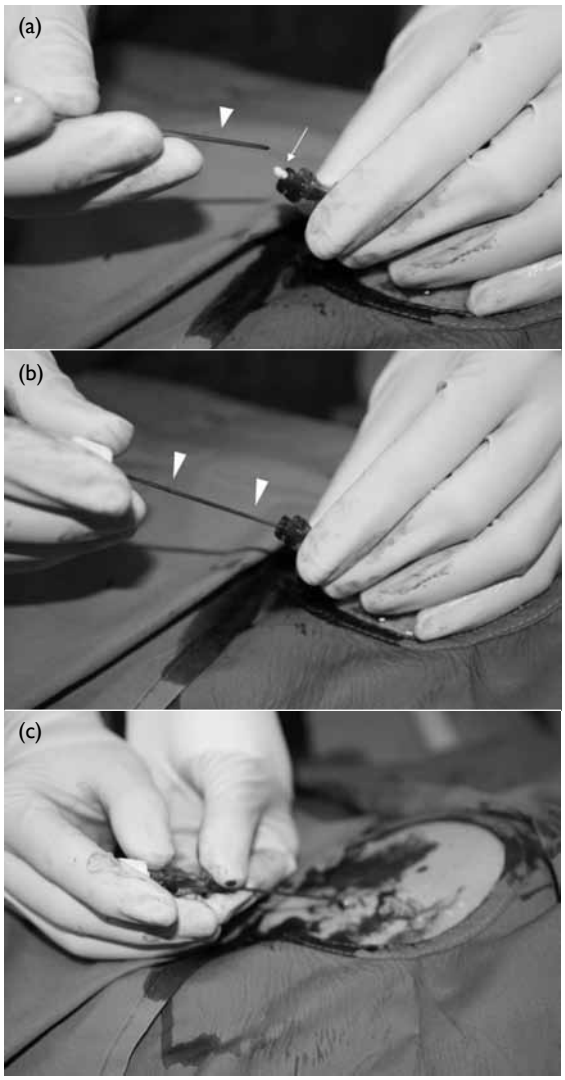

FIG 4. (a) Gelfoam torpedo (arrow) is placed at the hub of the coaxial introducer needle. (b) Gelfoam torpedo is then pushed by the stylet of the coaxial introducer needle (arrowheads). (c) The outer sheath of the coaxial introducer needle is withdrawn with the stylet stays still so that the Gelfoam torpedo can be deployed and seals the biopsy tract

peripheral subcapsular location, close proximity to major vessels, hypervascularity, and hypervascular biopsy sites (such as the spleen). Technical factors include increased numbers of needle passes, large needle sizes, use of cutting needles, blind biopsies, and less-experienced operators.[3] Patient factors include coagulopathy, platelet dysfunction or thrombocytopenia, medications (eg antiplatelet agents and anticoagulants), chronic liver disease, haematological malignancy, presence of moderate-to-severe ascites, and uncooperative patients.[2,4,5] Some studies showed that peripheral blood coagulation indices have a poor correlation with liver bleeding time following laparoscopic biopsy, which might be caused by low regional platelet counts, clotting factor deficiencies in the liver parenchyma, and the lack of mechanical compression of the biopsy tract by inelastic tissue (eg cirrhotic liver).[6] Therefore operators should always be prepared for the possibility of significant post-biopsy haemorrhage, even in patients with normal clotting profiles and platelet counts.

Obviously, the main contra-indication to image-guided percutaneous solid organ biopsy is a bleeding diathesis.[2] However, histological diagnosis is critical and even lifesaving, by means of achieving correct treatment. In the past, transjugular liver biopsy had been advocated in patients with bleeding diathesis, massive ascites, and poor respiratory control.[7,8] However, this has multiple disadvantages. In particular, it is not feasible for liver lesions far from the major hepatic veins. Moreover, it is technically demanding and associated with a high rate of insufficient specimen retrieval for satisfactory histological examination (11.2-29%).[7,9-12] It can also give rise to complications at the puncture site (jugular vein) and induce arrhythmias during right atrial passage. Haemoperitoneum is possible if the liver capsule is perforated, which can sometimes be fatal.

Plugged percutaneous biopsy is an alternative to transjugular liver biopsy in patients at high risk of bleeding.[2,8,13] It was first described by Riley et al in 1984.[13] In plugged biopsy, the tract is embolised (plugged) after the percutaneous biopsy, thus decreasing the risk of haemorrhage. Multiple studies on PPB have demonstrated at least a 95% success rate in obtaining adequate specimens for histological diagnoses. It is also a safe procedure with a complication rate of less than 2% (Table 2[7-9,14-16]). It has the obvious advantages of being direct and can be used to biopsy focal hepatic lesions away from major hepatic veins and in other organs. Also, a larger biopsy needle can be used, which increases the chance of obtaining adequate specimens. Finally, it does not involve the vascular system or passage through the right atrium and thus the relevant complications can be avoided.

TABLE 2. Comparison of the results of various plugged biopsy studies

Study	No. of biopsies	No. (%) of diagnostic samples	Embolic agent	Needle type	No. (%) of complications
Tobin and Gilmore,[14] 1989	100	100 (100)	Gelatin sponge	Tru-cut	0 (0)
Zins et al,[7] 1992	78	74 (95)	Gelatin sponge and thrombin	Sure-cut	2 (2)
Sawyerr et al,[15] 1993	56	55 (98)	Gelatin sponge	Biopty-cut	2 (4)
Smith et al,[16] 1996	80	80 (100)	Gelatin sponge	Tru-cut	6 (8)
Kamphuisen et al[9], 2002	39	39 (100)	Ivalon	Tru-cut	0 (0)
Atar et al,[8] 2010	233	231 (99)	Gelatin sponge	Quick-core	0 (0)
Total	**586**	**579 (99)**	**-**	**-**	**10 (1.7)**

The most commonly used embolic agent is Gelfoam, which is an absorbable compressed gelatin sponge prepared from purified porcine skin.[3,7] It is capable of absorbing up to 45 times its weight of whole blood, and induces haemostasis by speeding up thrombus formation and providing structural support for the clot. Gelfoam is a temporary embolic agent, which is usually completely absorbed within a few days or weeks, depending on the amount used, the degree of saturation with blood, and the application site. It is widely used in tract plugging as it is relatively inexpensive and readily available. It is easy to use and can be prepared in different forms, depending on the site of application. In our centre, Gelfoam was prepared in the form of torpedo and slurry. The Gelfoam torpedo was made from tight rolling of a small strip and used at the site of active bleeding. Due to their larger size, Gelfoam torpedoes can remain at the site of deployment instead of being flushed away by blood. The drawback of the torpedo is that distal embolisation cannot be achieved. In contrast, Gelfoam slurry is suitable for distal embolisation. It can be prepared by mixing tiny Gelfoam pledgets with contrast or saline. Further decrease in size of the pledgets can be created by macerating the suspension with two syringes and a 3-way stopcock. The syringe should be held nose up as Gelfoam floats in fluid. The disadvantage of slurry is that it is difficult to deploy at sites of active bleeding, as the suspension can be flushed away by blood. In our centre, we injected Gelfoam slurry first for distal embolisation and then filled up the rest of the biopsy tract with a torpedo. To the best of our knowledge, plugging of the biopsy tract using a combination of Gelfoam slurry followed by Gelfoam torpedo is a new technique that has not been previously described. Gelfoam is safe to use most of the time, although there is a minute risk of non-targeted embolisation of the biliary or vascular systems and of becoming a nidus for microbial growth.[3]

Apart from plugging of the biopsy tract, there are other measures to decrease the risk of bleeding in patients undergoing solid organ biopsy. First, as appropriate, we should try to correct any coagulopathy by administration of fresh frozen plasma, platelets, coagulation factors, and vitamin K, whilst also withholding antiplatelet or anticoagulant medications if at all feasible. Although not related to the bleeding risk, red cell or whole blood transfusion should be given before the biopsy to significantly anaemic patients. Next, careful planning of the method of biopsy is important. A safe biopsy path not traversing vessels or critical structures should be sought. Leaving adequate distance of normal parenchyma from the organ capsule and the biopsy site can also help mechanical compression of the biopsy tract by virtue of tissue elasticity, after the needle is removed. We have to strike a balance between the tissue yield and the use of smaller needles. The use of a coaxial system allows multiple needle passes with just a single puncture. Reducing ascites, if present with diuretics or paracentesis, can also decrease the risk of haemorrhage.

One limitation of our study was the small sample size. Second, it was a retrospective observational study without a control group. A large-scale prospective randomised controlled study may be ideal to validate the efficacy and safety of PPB. We share our experience in this small-scale study to raise the awareness of this procedure (especially for those not specialised in interventional radiology), as it shows that PPB is a simple and safe method with a high technical success rate that can help prevent post-biopsy haemorrhage.

Conclusion

Plugging of the biopsy tract with Gelfoam slurry followed by a Gelfoam torpedo is a direct, simple, safe, and effective means of preventing haemorrhage in patients at high risk of post-biopsy haemorrhage.

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